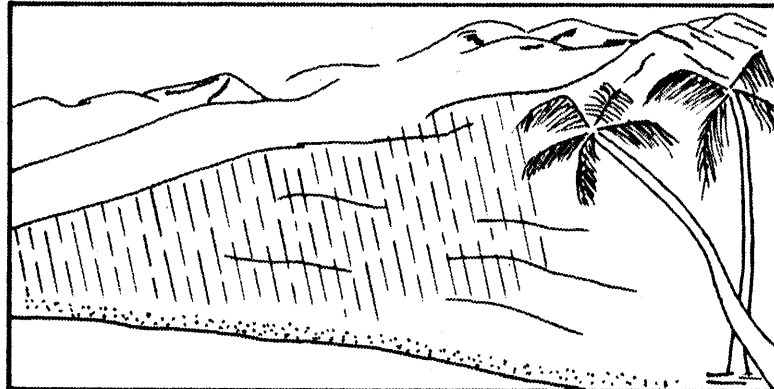


# MAIN REPORT

## FLOOD PLAIN INFORMATION STUDY KOLOA-POIPU, KAUAI, HAWAII



PREPARED FOR  
BOARD OF LAND AND NATURAL RESOURCES  
STATE OF HAWAII



BY  
U. S. ARMY ENGINEER DISTRICT, HONOLULU  
CORPS OF ENGINEERS  
HONOLULU, HAWAII

OCTOBER 1966

FLOOD PLAIN INFORMATION STUDY

KOLOA-POIPU, KAUAI, HAWAII

MAIN REPORT

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FLOOD PLAIN INFORMATION  
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MAIN REPORT

I. INTRODUCTION

1. AUTHORIZATION

This report has been prepared by the Corps of Engineers at the request of the State of Hawaii Board of Land and Natural Resources. Section 206, Public Law 86-645 (Flood Control Act of 1960), grants authority to the Secretary of the Army, through the Chief of Engineers, to gather and distribute information concerning past floods and flood hazards in flood-prone areas. The Hawaii Board of Land and Natural Resources and the Chief of Engineers have reviewed and approved the release of this report.

2. PURPOSE OF STUDY

Purposes of the study are:

a. To provide information on hazards to life and property in the Koloa-Poipu area caused by overland, sheet-flow flooding.

b. To provide a basis for local planning decisions.

c. To outline measures to minimize flood damages.

d. To reduce future expenditures of the Federal and local governments in protecting developments that may be constructed in the area in the absence of regulations or knowledge of potential hazards.

In this report the term of reference "Koloa-Poipu" is restricted to that coastal area within the district of Koloa from Waikomo Stream to Pihakekua. This area is commonly known as Poipu.

3. USE OF REPORT

The main portion of this report outlines flood problems and presents general guidelines to reduce future flood losses. This portion of the report is primarily intended for use by present and prospective land owners and residents, as well as developers, investors, realtors, governmental bodies and others with interest in the area. The technical appendix is included primarily for engineers or others who may find this information useful in designing or planning future improvements in the Koloa-Poipu area.

This report is not intended to extend any Federal control or jurisdiction in flood plain planning or regulation. In addition, it in no way obligates the Federal Government to further investigating, planning, designing, constructing, operating or maintaining any facilities discussed unless such action is authorized by Congress.

The Board of Land and Natural Resources was designated as the coordinating agency for the State of Hawaii by Act 148, Session Laws of Hawaii, 1963. This agency will distribute copies of the report to interested parties and individuals upon request.

#### 4. ACKNOWLEDGMENTS

The cooperation of the following agencies and individuals for their help in compiling this report is gratefully acknowledged.

Department of Agriculture - Soil Conservation Service  
Department of Commerce - U.S. Weather Bureau  
Department of Interior - Fish and Wildlife Service  
" " - U.S. Geological Survey  
" " - National Park Service  
State of Hawaii - Department of Land and Natural Resources  
" " - Department of Transportation  
" " - University of Hawaii  
County of Kauai, Hawaii  
Newspapers - The Garden Island Publishing Company, Ltd.  
" - Honolulu Star-Bulletin  
" - Honolulu Advertiser  
Grove Farm Sugar Plantation Company  
Residents of the Koloa-Poipu area

## II. FLOOD HISTORY

#### 5. GENERAL

Koloa-Poipu is on the south side of the island of Kauai, about 8 miles from Lihue, as shown on plate 1. The 1960 population of Kauai was 28,200 with about 4,400 and 400 people living in the Koloa and Poipu areas, respectively. Almost the entire population of Poipu reside in the low, level areas along the coast with the heavier concentration towards the east in the vicinity of Poipu Beach. In recent years Poipu has developed into a popular resort. New residences, hotels and related business establishments have been constructed and new developments are being planned for the near future. The New Poipu Road, built in 1964, is the only major roadway servicing this resort area. The Old Poipu Road is no longer a through street. The New Poipu Road is a paved, 2-lane highway, 600 to 1200 feet north of the Old Poipu Road (see plate 2) and contains culverts at 5 different locations, including a double celled, 10-foot radius culvert at Waikomo Stream. The Old Poipu Road has a 5-span timber bridge crossing Waikomo Stream. Waikomo Stream, which defines the western boundary of the study area, drains an area of 10.4 square miles.

Poipu has a total drainage area of 3.47 square miles extending about 3.5 miles northward from the ocean shore (see plate 1). Over 95 percent of the drainage area is comprised of brush and sugar cane fields. See figures 1, 2, and 3 for views of the drainage basin.

Plates 1 and 2 show the locations from which photographs were taken. Present land use in the lower part of the basin consists of residential housing, beach homes, resort hotels and motels with supporting businesses, recreational facilities and a public park.

## 6. RAINFALL

Rainfall records through the southern part of Kauai show that the mean annual rainfall ranges from 35 inches along the coast at Poipu to 80 inches at the northern drainage divide, 800 feet above mean sea level. Storms that cause flooding are usually of short duration and high intensity.

## 7. FLOODS

The flood problem of the Koloa-Poipu area is confined mainly to the coastal land below the 10-foot contour, comprising about 75 acres. Since there are no defined stream channels, the area is normally dry. Runoff in the form of a "sheet" of water occurs only when heavy rain falls in a short period of time. As the water flows overland, it fills the many depressions behind the old Poipu Beach Road, forming ponds with flood waters entering low-lying houses and business establishments. These low areas do not have outlets to the sea so the water may stand in the ponds for several days and be a nuisance and health hazard. Figures 4 through 10 show views of the general area and some areas that are often flooded (see plate 2).

Figures 4 and 5 are views of residences on the west side of the study area. Flooding in this area is caused by sheet flow and is usually limited to the yards. There is little danger of ponding in this area.

Figures 6 and 7 show low-lying areas on both sides of Hapa Road that are affected by recurring floods. When heavy rain occurs, the surface water from the basin passes through culverts under the New Poipu Road and into the coastal ponding areas. Overflow water from the lakes thus formed finds its way to the ocean across the Old Poipu Road and through the densely populated beach front causing damages to property. The New Poipu Road culverts are not the cause of flooding in the lower areas for floods occurred before the construction of the New Poipu Road.

Figures 8, 9, and 10 are views of the area called Bacle Tract. This area is more seriously affected by floods than other areas of Poipu. In times of heavy rain, water is funneled into the residential area at the eastern side of Bacle Tract through a swale and ponds at the intersection of Kuai Road and Poipu Beach Road, causing damages to property, isolating homes and making roads impassable. Overflow water finds its way through the beach front properties to the ocean. The remaining water must be removed by pumping into the ocean.

During the past 12 years, there were 6 significant storms in the area. This indicates that, on the average, every 2 years the Koloa-Poipu area is subject to property damage and losses by floods. Small floods causing minor damages are not included in the above statistics.

Newspaper records and the U. S. Weather Bureau's Climatological Data were used to obtain historical data on floods and rainfall in Koloa-Poipu, Kauai. The following excerpts describe past storms in and near the flood plain study area.

November 28, 1954 - High winds and heavy rains caused flooding of the lowlying Poipu area across the highway from the beach. Two homes were flooded and several others were in danger of being flooded. Two automobiles belonging to a family were almost completely submerged. The two cars were in the garage. One family, after a busy effort of moving furniture, finally had to be evacuated from their home by boat. The boat was also used to remove possessions from another home that was flooded. Water draining off the fields and wastelands into Poipu, the coastal basin, created a vast lake. The rain had let up when the water rose between 9 a.m. and 10 a.m. to flood stage, making the highway impassable at a point shortly beyond the YMCA Memorial Building. Fire Department trucks ran their pumps without pause from Sunday until 2 a.m. Tuesday.

November 8-9, 1955 - The water rose this morning to cover a wide stretch of the Poipu Road, isolating families living beyond the Poipu Beach area. No relief was yet in sight as the heavy rainstorm of yesterday and today is expected to continue through Thursday. For the Poipu residents, traffic probably will be blocked for another three days or more. A boat has been brought in to ferry people across the flooded section. One family has been evacuated because of rising flood water but otherwise property damage was less than in the last Poipu flooding, although the water is higher. One reason is that some of the residents took warning yesterday and moved their cars to safer ground. The rainfall recorded at the airport for the 24 hours up to 8 a.m. today was 10 inches. Most of the rain (about 4 inches) fell between 2 and 8 p.m. yesterday. Between 2 and 8 a.m. today rainfall measured about 6 inches. The flooding of the Poipu Road extended from the house just west of Kuai Road to No Name Road. The deepest water on the road was about 4 feet at the dip in the road. One car got stalled running into deep water but was pulled back to safety. Traffic was halted and a few walked out to walk through property along the beach. The Koloa Fire Department arrived to start pumping the big lake. Some homes sustained damages to furniture.

January 17-18, 1957 - Kona weather brought extremely heavy rainfall to many parts of the island. The highest one-day totals were recorded at Grove Farm's Makaulepu gauge, which had 11.97 inches Friday morning. The gauge at Makahuena Point had 11.23 inches for a similar period. The 7-day rainfall at Makaulepu was 16.6 inches. The heavy rains turned the eastern half of Poipu into lakes. Poipu Road was turned into a canal by the heavy rainstorm, giving the Fire Department trucks a big pumping job.



April 14, 1965 - Heavy rains and high winds caused some damage on the south and west sides of the island early Tuesday morning. The rains caused flooding in the Poipu area. About 2.5 inches of rain fell in the Koloa area during the storm which lasted something over an hour. The result was flooding in the Bacle Tract area. Traffic was blocked on Poipu Road for sometime Tuesday until the water could be pumped by the Fire Department.

November 14, 1965 - Runoff water in the Poipu area accumulated near the Waiohai Hotel on Sunday afternoon but caused no damage. County trucks were called to pump the water out of low spots.

November 19, 1965 - Heavy rains which fell on Kauai in the morning have caused flooding at Poipu. Runoff water accumulated in the Waiohai Hotel grounds at Bacle Tract and the Weliweli area of Poipu just before day-break. Local residents said the flood was the highest they have seen in the Bacle Tract area, which has no natural or man-made outlet to the sea. County firemen began pumping the water at 6 a.m. and were still pumping at 6:30 p.m. Residents of the flooded area were evacuated from the low-lying areas. At least two cars were under water and one resident's furniture was floating around his yard. Working men and women living east of the flood zone had to hike across yards and thumb rides to work Friday morning. Most of the Koloa area received 3.5 inches of rain or more overnight.

An inspection of the area topography determined the various paths water travels on its way to the ocean. Six concentration points exist along Old Poipu Road with drainage areas ranging from 0.08 to 1.87 square miles. These areas are shown on plate 1.

Flood flow which would result from the most intense storm considered reasonably characteristic of the Koloa-Poipu region is called the "Standard Project Flood" by the U.S. Army Corps of Engineers. Values of the standard project flood for Areas A through F and Waikomo Stream are given in table 1. The frequency of occurrence of various magnitudes of flood flows are also listed in table 1. This information will serve as a guideline to determine flood plain areas in which a greater degree of flood risk may be permissible. Since floods are random in nature, frequency is only a prediction based on studies of past floods. The assignment of a 10-year frequency to a given stream flow does not mean that the flood will occur every 10 years. Instead, it is an indication that the particular peak discharge, expressed in cubic feet per second, will be exceeded on an average of about once in every 10 years. This means that during a long period of time, say 100 years, a 10-year flood will be exceeded about 10 times. Frequency estimates for Koloa-Poipu (Areas A thru F) and Waikomo Stream were based on the frequency curve for Hanapepe Stream gaging station, which is about 8 miles northwest of Koloa, and has been in operation since 1918. The technical appendix contains the flow frequency curves for the study subareas and Waikomo Stream.

Table 1. Flood Flow-Frequency Relationships

Recurrence Interval in Years	Area A	Area B	Area C	Area D	Area E	Area F	Waikomo
	(C.P. 1) Drainage Area 0.45 sq. mi.	(C.P. 2) Drainage Area 0.11 sq. mi.	(C.P. 3) Drainage Area 0.22 sq. mi.	(C.P. 4) Drainage Area 0.08 sq. mi.	(C.P. 5) Drainage Area 0.74 sq. mi.	(C.P. 6) Drainage Area 1.87 sq. mi.	(C.P.7) Drainage Area 10.4 sq. mi.
Peak Flow in Cubic Feet Per Second							
10	670	190	360	140	1,100	2,450	9,900
50	1,030	290	560	220	1,670	3,800	15,700
100	1,200	340	650	250	1,950	4,500	18,200
Standard Project Flood	1,490	440	820	330	2,530	5,350	26,400

Concentration points for the 6 subareas and Waikomo Stream are shown on plate 2.

## 8. STREAM FLOOD

The lower reach of Waikomo Stream does not have the capacity to contain discharges in the magnitude of the standard project flood (26,400 c.f.s.) or of the 100-year frequency flood (18,200 c.f.s.). The cross sectional area of the stream and the culvert and bridge openings under the highways are inadequate. The New Poipu Road culvert, for instance, has a capacity to pass only about 7,000 c.f.s. As a result, any unusual storm could cause stream overflow. See figures 11, 12 and 13 for views of the stream. Flooding in the lower reach of Waikomo Stream would inundate the area between the stream and drainage Area A and cause water to flow southward on the east bank along and across the Old Poipu Road as far east as Area B. This flood area contains only a few houses. Areas east of drainage Area B would not be affected by flooding of Waikomo Stream.

## 9. RESERVOIR

Waia Reservoir, just north of the Poipu drainage areas, was constructed prior to 1900 to store irrigation water for the growing of sugar cane. In 1910 the reservoir was expanded to the present size. This privately owned reservoir has a maximum capacity of 2,300,000,000 gallons of water. Through the years the dam has not sustained major damage, nor has it overflowed except for a more or less controlled release through the spillway on the southwest corner. The highest water level in the reservoir was recorded in 1917 when it rose to 5 feet below the top of the dam. This is only about 1.5 feet above normal water level. The data included in the report on sizes and frequencies of future floods are based on the assumption that the dam will not fail or be overtopped. Plate 1 shows the location of the reservoir, and figures 14, 15, and 16 show views of the spillway and dam.

## 10. TSUNAMI

Another potential source of flooding is the tsunami which runs onto the beach and coastal lowland areas of the Hawaiian Islands. The tsunami has never caused much damage in the Koloa-Poipu area, but the possibility still exists that the entire coastal development could be severely damaged by tsunami. During the past 147 years, 43 tsunamis have been known to affect the Hawaiian Islands. Seven were designated very severe, 2 severe, 8 moderate, and 26 slight, judged by the amount of physical damage inflicted.

An indication of the damage caused by tsunami is shown by the losses to the city of Hilo, Hawaii on 23 May 1960. There were 61 people killed, 537 buildings destroyed and \$22 million damages sustained when this tsunami caused the water to reach an elevation of 28 feet above mean sea level.

### III. FUTURE IMPROVEMENTS IN THE FLOOD PLAIN

#### 11. GENERAL

The drainage configuration and corresponding flood flows are based on the present land use of the area. Future improvements that materially change the route of flood flows through an area may cause adjacent areas to be affected more severely than at the present time.

Future improvements planned for the flood plain are discussed in the following paragraphs.

#### 12. GENERAL PLAN

The State Planning Office, together with the Department of Transportation, submitted a plan of development to the State Legislature in January 1961 entitled "The General Plan of the State of Hawaii." It was adopted and released to the Department of Planning and Economic Development for use in planning land utilization policies. In 1962 the Planning and Traffic Commission of the County of Kauai formulated a General Plan for the county. Since the County General Plan was formulated in close coordination with the State, the plans are in agreement. Each sets forth a long-range, comprehensive, coordinated program in land use to serve as a guide for future planning and development. The objectives are, briefly, to promote a healthier and more attractive community socially, physically, and economically. The plans are flexible to changes in population and economic climate of the locality. The county has the responsibility of implementing the plans by adopting controls such as zoning regulations.

#### 13. RESIDENTIAL SUBDIVISION

At Poipu, the General Plan designates the area west of Pau-a-laka Gardens and north of the Old Poipu Road up to about the 40-foot contour a residential area. A portion of this residential area is being subdivided by private developers into about 50 half-acre lots, or a total of 25 acres. The land will be sold in fee simple and individuals interested in buying land should be aware of potential floods and tsunamis in building along this coastal flood plain. This subdivision land lies between elevations 10 and 40 feet above m.s.l.

Plans for a new subdivision called "Weliweli Houselots" have recently been approved by the county of Kauai and the State of Hawaii. The plan calls for 99 houselots over a total area of about 31 acres to the north of and adjoining Bacle Tract. This tract of land, oriented with the long axis (3400 feet) north to south, is entirely within Drainage Area F, between the 20 and 100 foot contours.

#### 14. HIGHWAY MODIFICATION

A new highway about 1200 feet from the shore has been completed. The old coastal road, which is from 100 to 600 feet

inland, is still in use but plans are to eliminate the coastal road and develop the entire 1200 feet of land between the new highway and the shore.

#### 15. RESORT DEVELOPMENT

The Kauai General Plan presents 5 planning areas for Kauai. Of these five, the Koloa area is expected to have the greatest growth in population and economy. It is estimated that by 1980 a population of about 25,000 may be reached. This forecast is attributed largely to the expected growth of the resort areas of Kukuiula and Poipu. In keeping with this thinking, the General Plan designates two sections totaling about 68 acres of the Poipu study area for the development of resorts. One section extends from the Pau-a-laka Gardens to the eastern end of the golf course and from the shore to about the 20-foot contour. The second section extends from the western side of Bacle Tract to the hills of Pihakekua and from the shore to the northern limits of Bacle Tract.

This report is specifically directed towards those parties and individuals, both private and governmental, who are interested in the development of the Koloa-Poipu area. Future flood losses can be greatly reduced if proper and adequate precautions are taken regarding planned development in the flood-prone areas. Flood plain zoning ordinances could be enacted that would prohibit building residences in an area which is subject to periodic flooding that would endanger the health or safety of the occupants.

#### IV. GUIDE LINES FOR USE OF FLOOD PLAIN AND REDUCING FUTURE FLOOD LOSSES

#### 16. GENERAL

The preceding discussion of the actual and potential floods and tsunami in the Koloa-Poipu area emphasizes the need for regulations to control land use in the flood plain. The enactment and enforcement of the proper laws and ordinances are the responsibility of local authorities. The following discussion assumes that part of the existing flood plain will be reserved for the free passage of flood waters with a minimum of obstruction to its flow. Methods to preserve this area are outlined under the heading of flood plain regulations. Avenues of investigation for the protection of existing improvements are also presented.

#### 17. FLOOD PLAIN REGULATIONS

The police powers of state and local governments to enact and enforce laws and ordinances regulating land use furnish methods to carry out the concepts of paragraph 16. Included within the scope of flood plain regulation are zoning ordinances, subdivision regulations, channel and floodway encroachment statutes and building codes.

The intent of these restrictions is to deny uses of the land or property in the Koloa-Poipu flood plain that would tend to multiply the loss of life and property through development without adequate consideration of flood hazards.

a. Zoning ordinances. Zoning ordinances control the type of land use that will be permitted in an area. Regardless of the method used, specific instructions concerning what land use activity will be permitted within the restricted areas should be included.

b. Subdivision regulations. Proposed subdivisions that lie in flood-prone areas should have regulations that clearly define the degree of risk and extent of flooding involved. Such items as minimum lot, street or structural elevations, outline of flood plain for various frequencies of flow, and minimum surface drainage requirements should be an integral part of these regulations.

c. Channel and flood plain encroachment statutes. Encroachment statutes designate areas adjacent to bodies of water that are set aside for the passage of flood flows. Obstructions such as structures or trees should be held to a minimum in these areas. These statutes, together with applicable zoning ordinances, constitute the means for preserving a permanent floodway by permitting only such improvements as playgrounds, which offer a minimum resistance to flood flows and can withstand inundation with little damage.

d. Building codes. Building codes for flood plain development should specify (1) minimum elevation of footings, (2) minimum first floor elevations, (3) require such reinforcement to withstand high velocity flow and water pressure, (4) designate minimum requirements of flood proofing, and (5) control construction of basements.

e. Other controls. Government and private lending agencies can exercise an indirect control over flood plain development by refusing to finance improvements to be located in an existing or potential flood hazard area. Also, land fill or dumping operations should be controlled in the area designated to carry off the flood waters. The acquisition of the flood plain area by easement or in fee simple title by local or state governments for recreation or open space use would put it to uses compatible with the flood hazard. Finally, major drainage and flood channels should be established as the areas are subdivided or developed.

## 18. METHODS TO PROTECT EXISTING IMPROVEMENTS

Control of the flood waters in the Poipu area by constructing diversion channels and building levees would be a solution of the flood problem. Since direct flood control for any of the areas seems unlikely at the present time, two methods may give partial protection to the existing improvements in the flood plains.

a. Flood proofing. Flood proofing could be used for the present structures subject to flooding and incorporated into the basic design for any future buildings planned. This involves raising vulnerable

equipment such as generators, motors, and machinery above the high water profile for a given flood and emergency installation consisting of water-tight doors, windows, walls and ground level air vent coverings. These methods would be effective only for flooding from surface water flow. They would offer no protection from tsunami because of the tremendous forces associated with them. The University of Chicago, Department of Geography, Research Paper No. 65, "Flood Proofing: An Element in a Flood Damage Reduction Program," 1960, by John Richard Sheaffer is a comprehensive discussion of some of the flood proofing techniques that can be employed.

b. Evacuation. Temporary evacuation of movable property is effective only if coupled with an adequate flood warning system. The Kauai Civil Defense Agency has a network system to warn of any impending tsunami. Presently there is no system to predict rain storm floods in the Poipu area except the U.S. Weather Bureau's forecasts of probable heavy rains and possible flooding. Once alerted, residents can either remove their personal property to higher ground or raise it to a safe level and evacuate the area.

#### V. CONCLUSION

This report has presented a history and problems of flooding in the Koloa-Poipu area and guidelines for reducing flood damages. Guidelines for the future control of damages resulting from these conditions have also been presented. Recognition of the danger from flooding to low areas and possible flood losses that may result is imperative at this time. Now is the time to act before extensive development and new construction is undertaken.

The information and suggestions in this report are presented to help the State, County of Kauai, and other interested agencies and individuals to plan and regulate land use in the Koloa-Poipu area.

WILLIAM F. ROOS  
Colonel, Corps of Engineers  
District Engineer

## GLOSSARY OF SELECTED TERMS

### A. HYDROLOGIC TERMS

Channel - A natural or artificial watercourse with definite bed and banks to confine and conduct flowing water.

Flood - A temporary overflow of lands not normally covered by water, which lands are used or usable by man when not inundated.

Flood plain - The relatively flat lowlands adjoining a watercourse or other body of water subject to overflow therefrom.

Flood profile - The longitudinal profile assumed by the surface of a stream of water flowing in an open channel.

Flood frequency - The average interval of time, based on the period of record, between floods equal to or greater than the specified discharge. Frequency is generally expressed in years.

Rainfall intensity - The amount of rain that falls in a specified time interval, usually expressed as inches per hour.

Recurrence interval - The average interval of time within which a particular flow will be exceeded once.

Standard project flood - A hypothetical flood, estimated by the Corps of Engineers, representing the critical flood runoff and peak flood flow that may be expected from the most severe combination of meteorological and hydrologic conditions that are considered reasonably characteristics of the geographical region involved, excluding extremely rare combinations.

Tsunami - A sea wave produced by submarine earth movement or volcanic eruption.

Watershed - The area drained by a stream or stream system.

### B. REGULATORY TERMS

Flood plain regulations - A general term applied to the full range of codes, ordinances, and other regulations relating to the use of land and construction within flood plain areas.

Subdivision regulations - Regulations and standards established by a local public authority, generally the local planning agency, with authority from a state enabling law, for the subdivision of land in order to secure coordinated land development, including adequate building sites and land for vital community services and facilities such as streets, utilities, schools and parks.



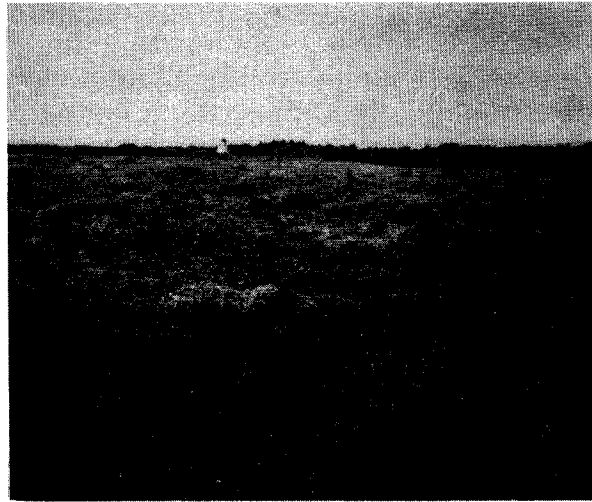


Figure 1  
Drainage basin - View looking south  
from the intersection of Weliweli Road  
and flume.



Figure 2  
Drainage basin - View looking south-  
west from eastern hills. Note  
harvested sugar cane land.

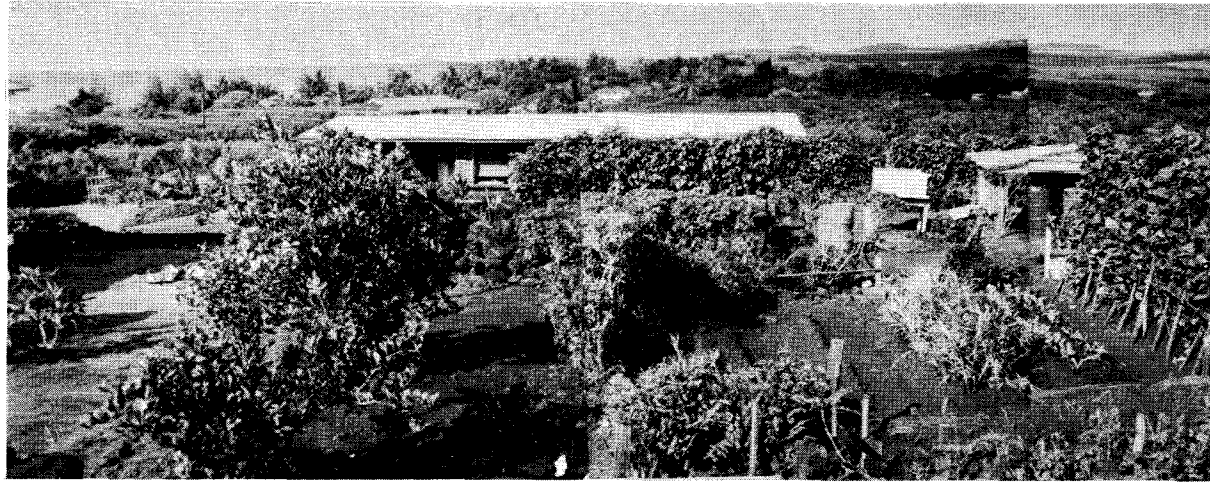


Figure 3

Drainage basin - View looking southwest from Pihakekua on the east side.

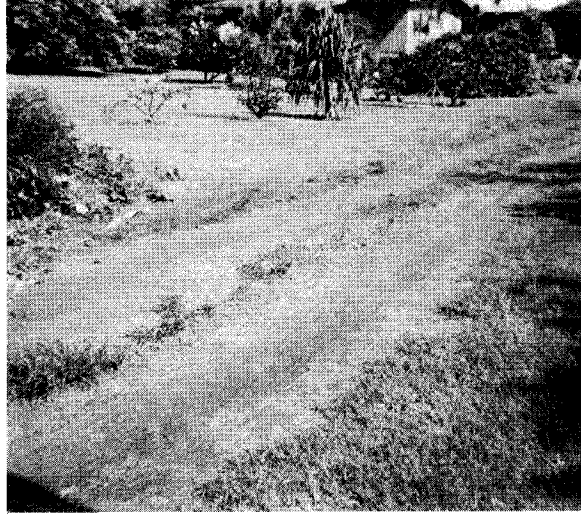


Figure 4  
West side of study area - view looking  
north into residence from old Poipu Road

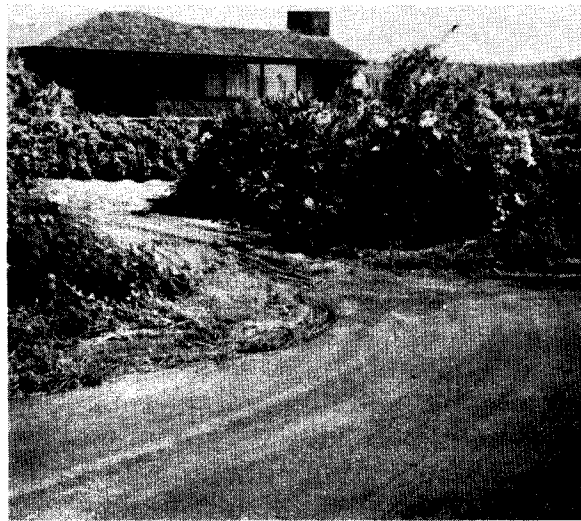


Figure 5  
West side of study area - View looking  
northeast into residence from old Poipu Road



Study area -



Figure 6

View of Pau-A-Laka Gardens



Figure 7  
Study area - View of pond near YMCA



Figure 8  
Study area - View looking north on Kuai Road



Figure 9  
Study area - View looking south on  
no-name road towards old Poipu Road



Figure 10  
Study area - View looking east from  
no-name road. House located in area.



Figure 11  
Waikomo Stream - View looking down-  
stream from a point about 1200 feet  
upstream of the new Poipu Road culvert.



Figure 12  
Waikomo Stream - View looking upstream  
from the new Poipu Road culvert.





Figure 13  
Waikomo Stream - View looking  
upstream from mouth.

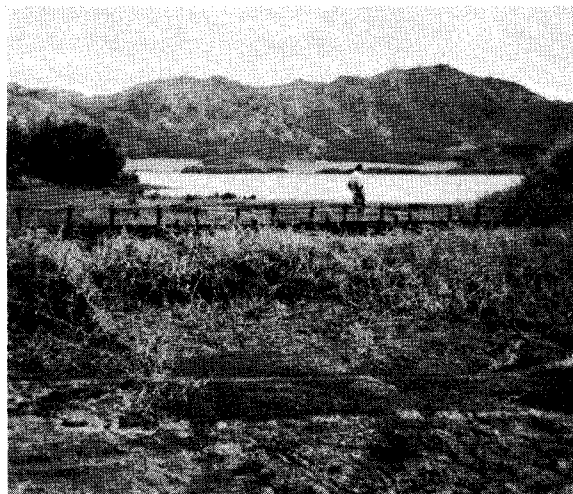


Figure 14  
Waita Reservoir - View looking  
northeast over spillway and into  
reservoir. Note flashboards.

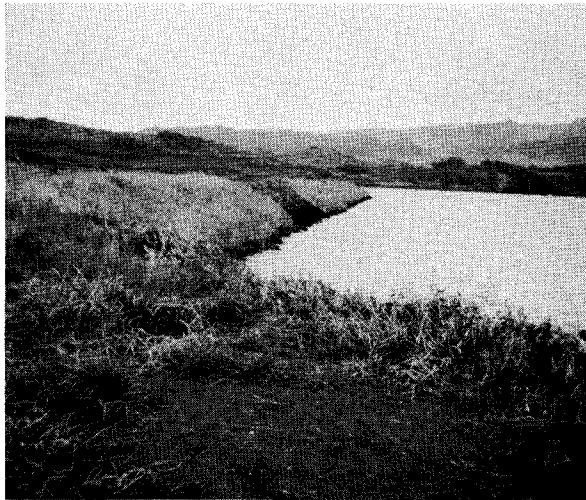


Figure 15  
Waita Reservoir - View looking  
west along dam.

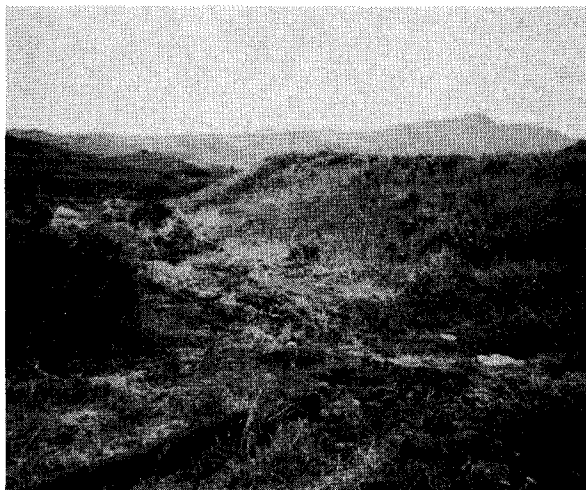
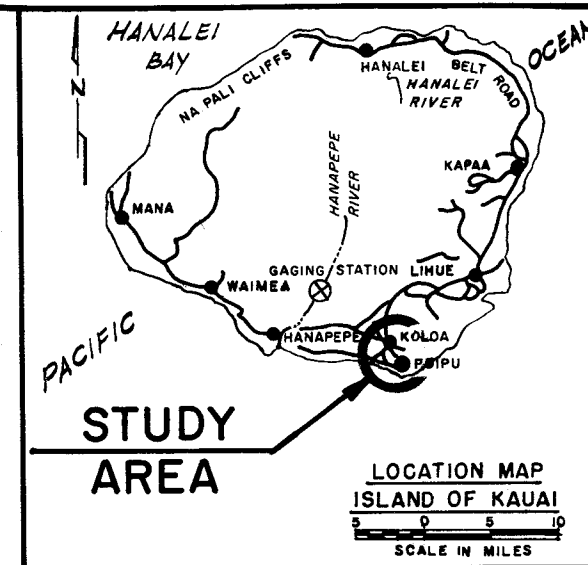
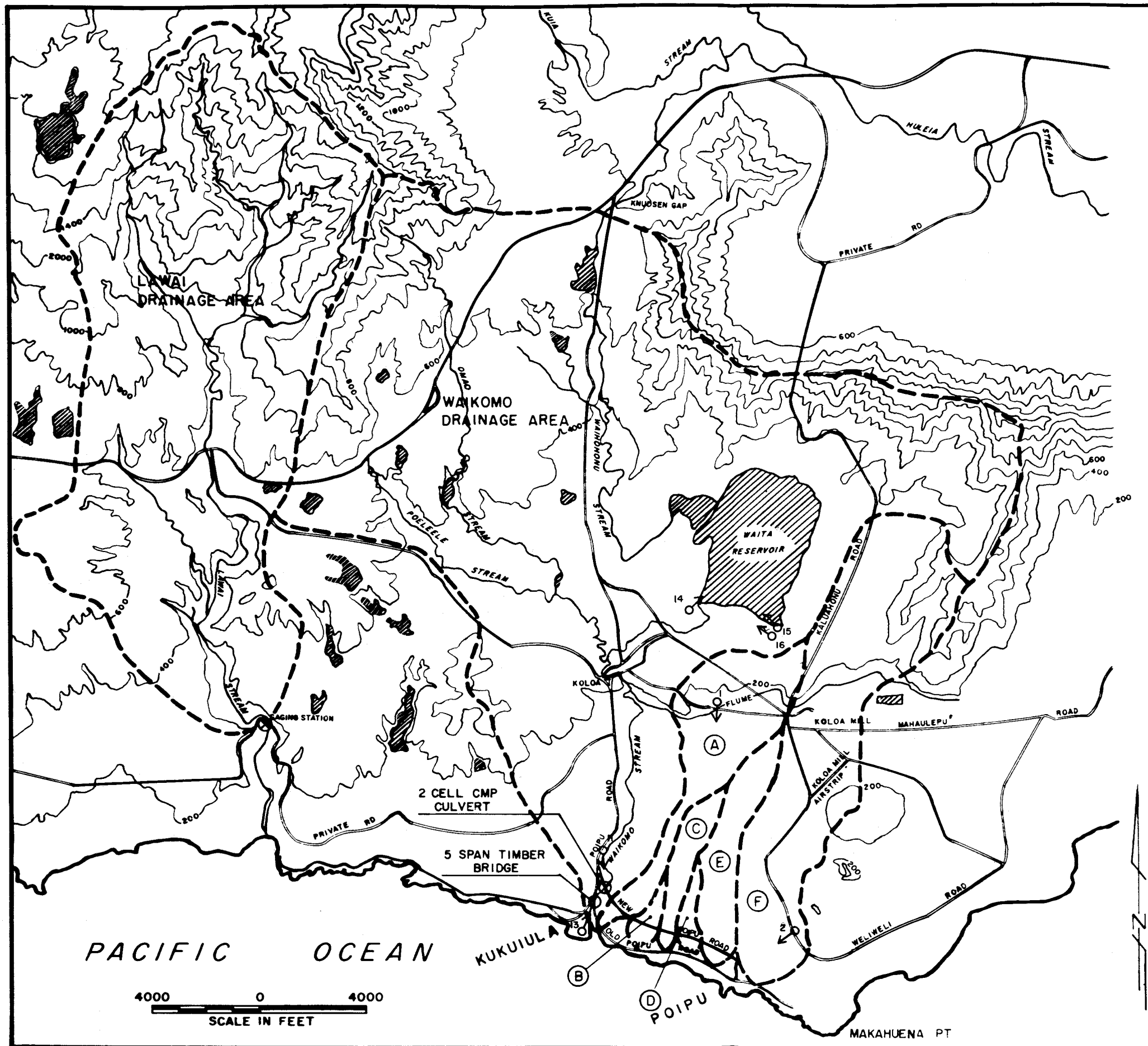


Figure 16  
Waita Reservoir - View looking  
west along backslope of dam.

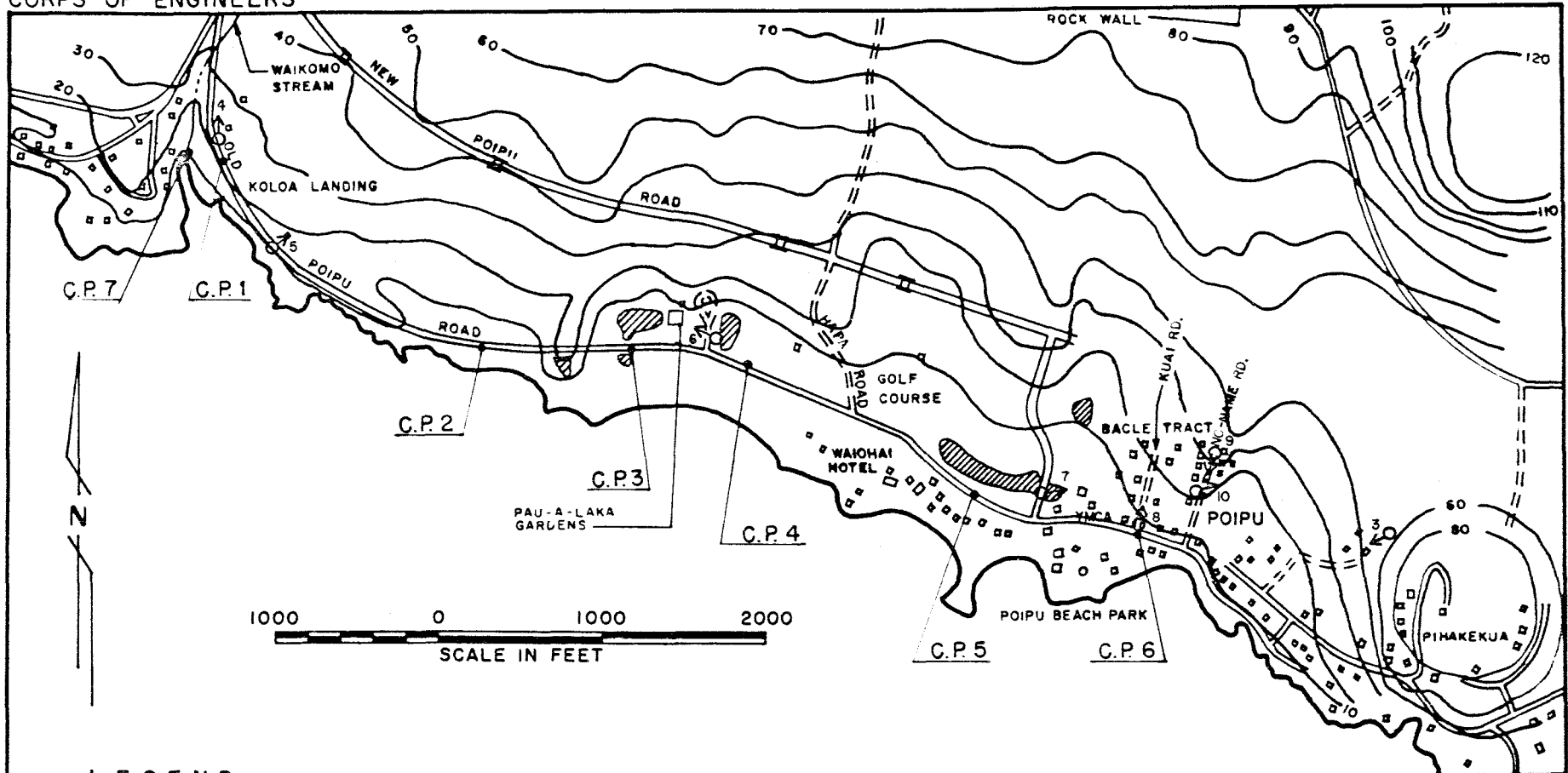


- LEGEND:**
- DRAINAGE AREAS
  - 200 — CONTOUR LINES
  - (A) KOLOA-POIPU DRAINAGE AREA
  - ▨ RESERVOIR
  - ↑ LOCATION AND DIRECTION OF PHOTOGRAPHS (See Figures)


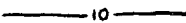



FLOOD PLAIN INFORMATION STUDY  
KOLOA-POIPU AREA  
KAUAI, HAWAII

DRAINAGE AREAS

U. S. ARMY ENGINEER DISTRICT, HONOLULU  
TO ACCOMPANY REPORT FILE NO.  
DATED: OCTOBER 1966 RH 38/600.1



LEGEND:

-  POND
-  CONTOUR LINES
-  C.P. CONCENTRATION POINT
-  CULVERT
-  LOCATION AND DIRECTION OF PHOTOGRAPHS (See Figures)

FLOOD PLAIN INFORMATION STUDY  
 KOLOA - POIPU AREA  
 KAUAI, HAWAII

**STUDY AREA**

U.S. ARMY ENGINEER DISTRICT, HONOLULU  
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